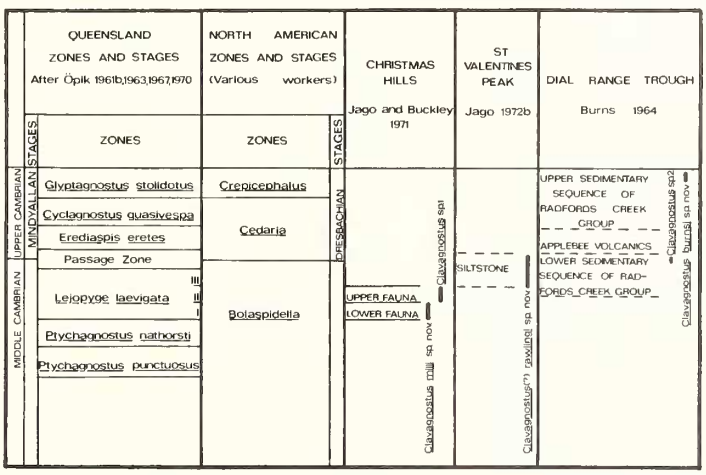
THE TRILOBITE *CLAVAGNOSTUS* HOWELL FROM THE CAMBRIAN OF TASMANIA

by J. B. JAGO *and* B. DAILY

ABSTRACT. Two new species of *Clavagnostus*, *C. milli* and *C. burnsi*, are described from the late Middle and early Upper Cambrian sequences of Tasmania. A third new species, *Clavagnostus*(?) *rawlingi* is questionably assigned to *Clavagnostus*. The genus *Clavagnostus* is reviewed. It is shown that the known species of *Clavagnostus* can be placed into three groups: (1) the *C. repandus* group which is characterized by a rounded glabellar front, no preglabellar median furrow, and a blunt pygidial axis which reaches the posterior border; (2) the *C. burnsi* group which is characterized by an angular glabellar front, a preglabellar median furrow, and a blunt pygidial axis which reaches the posterior border; and (3) the *C. sulcatus* group which is characterized by a preglabellar median furrow and a pointed pygidial axis.

It is shown that four and probably five different species of *Clavagnostus* have been included in *C. repandus*. The pygidium figured by Poulsen (1960) as the holotype of *Peronopsis ultima* is shown to be a cephalon of a species of *Clavagnostus*, probably that of *C. chipiquensis* (Rusconi).

THREE new agnostid species are described here: two of these are referred to *Clavagnostus*, a third is questionably assigned to *Clavagnostus*. Two isolated pygidia of *Clavagnostus* from separate localities are also described. All species come from the late Middle or early Upper Cambrian sequences of north-western Tasmania. Text-fig. 1 shows the correlation and stratigraphic distribution of the species described



TEXT-FIG. 1. Stratigraphic distribution of species of *Clavagnostus* from north-western Tasmania. Correlations between the Queensland and the North American zones are after Öpik (1963, 1967).

below as presently known. Text-fig. 2 indicates the geographic position of the localities noted below. The remaining trilobites from the Tasmanian localities noted herein will be described in later papers. The need for a review of *Clavagnostus* makes it desirable to describe the species of this genus separately.

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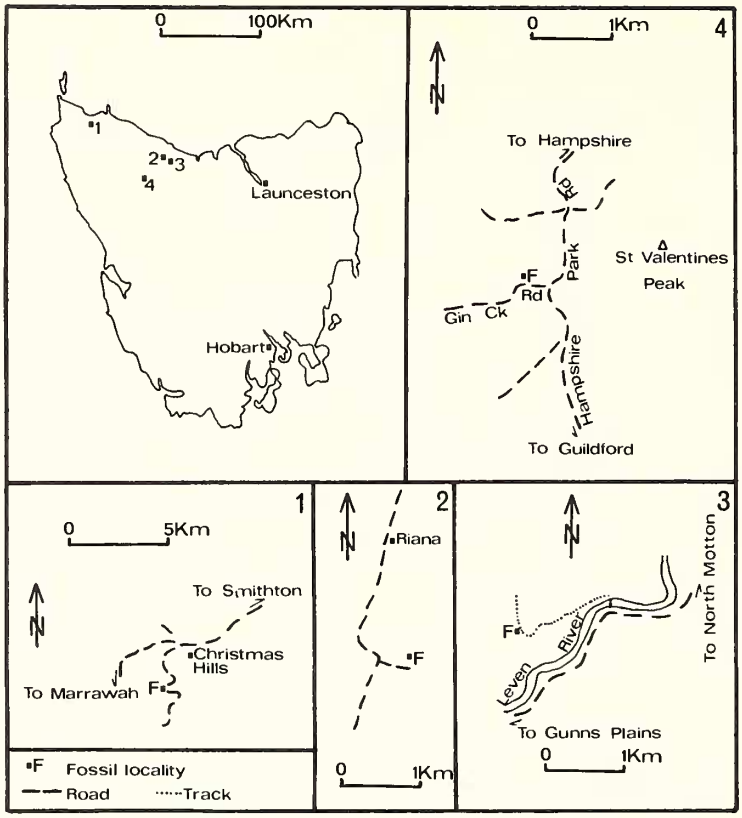

TEXT-FIG. 2. Locality Map.

In common with other Tasmanian Cambrian fossils the trilobites described below have undergone tectonic distortion. However, they are from localities where distortion is minimal. All specimens are preserved in siltstone as external and internal moulds. In order to prepare them for description, silicone rubber casts of the external moulds were prepared. These casts were then photographed after being whitened with magnesium oxide. All catalogue numbers refer to the collections of the Geology Department, University of Tasmania. The authors had at their disposal rubber casts of all the specimens of *Clavagnostus repandus* (Westergård) and *C. sulcatus* Westergård figured by Westergård (1946, pl. 4). Rubber casts of the specimen figured by Poulsen (1960, pl. 1, fig. 13) as the pygidium of *Peronopsis ultima* Poulsen and of the pygidium of *Clavagnostus chipiquensis* (Rusconi) figured by Poulsen (1960, pl. 1, fig. 14) were also available. All these specimens are refigured herein. The taxonomic terminology used in this paper is after Öpik (1961*a*, 1963, 1967). The agnostid trilobite classification of Öpik (1967) is followed here.

SYSTEMATIC DESCRIPTIONS

Order MIOMERA Jaekel, 1909
Suborder AGNOSTINA Salter, 1864
Superfamily AGNOSTACEA M'Coy, 1849
Family CLAVAGNOSTIDAE Howell, 1937
Subfamily CLAVAGNOSTINAE Howell, 1937
Genus CLAVAGNOSTUS Howell, 1937

Clavagnostus: Howell 1937, p. 1164; 1959, p. O 174; Kobayashi 1939, p. 120; 1943, p. 307; Lermontova 1940, p. 129; Westergård 1946, p. 55; Hupé 1953, p. 64; Pokrovskaya 1960*a*, p. 59; 1960*b*, p. 161; Öpik 1967, p. 114.
Tomorhachis: Resser 1938, p. 51.
Culipagnostus: Rusconi 1952, p. 11.

Type species. *Agnostus repandus* Westergård *in* Holm and Westergård, 1930, p. 13, pl. 4, figs. 11, 12 (only).

New diagnosis. Cephalon has glabella with no transverse glabellar furrow. Cephalic cheeks smooth. Cephalic spines, long to short. Glabella featureless except for a small to elongated node. Simplimarginate pygidium with long tapered axis. To the posterior of the axial centre is a pair of pits (the 'clavagnostid pits'). Transverse axial furrows effaced on anterior part of axis. Posterior part of axis depressed. Border spines, short to long.

Discussion. Species of the genus *Clavagnostus* have a very wide distribution in late Middle and early Upper Cambrian sediments. The type species *C. repandus* (Westergård) has been reported from north-west Siberia (Holm and Westergård 1930; Shabanov *et al.* 1967) and Sweden (Holm and Westergård 1930; Westergård 1946); *C. sulcatus* Westergård occurs in Sweden (Westergård 1946) and was recently reported from north-west Siberia by Lazarenko and Nikiforov (1968). Kobayashi (1943) described *C. repandiformis* Kobayashi and *C.* cf. *repandiformis* from Siberia. *C. ovalis* Pokrovskaya is found in the Sayan–Altai region (Pokrovskaya 1960*b*). *C. aequalis* Howell and *C. spinosa* (Resser) were described from Vermont and Alabama by Howell (1937) and Resser (1938). Drewes and Palmer (1957), Robison and Palmer (1968), and North (1971) have reported the occurrence of *Clavagnostus* from western North America. *C. chipiquensis* (Rusconi) was reported from Argentina by Rusconi (1952) and Poulsen (1960). Öpik (1967) described *C. bisectus* Öpik from Queensland. Prior to this paper *Clavagnostus* has been reported from Tasmania by Banks (1956, 1962), Blissett (1962), Burns (1964), Jago and Buckley (1971), and Jago (1972*b*).

The cephalon (holotype) and pygidium (both from the Andrarum Limestone, Andrarum, Scania) of *Clavagnostus repandus* figured by Holm and Westergård (1930, pl. 4, figs. 11, 12) and by Westergård (1946, pl. 4, figs. 19, 20) appear to be different from the cephalon and pygidium (from Sköllersta, Närke) figured as *C. repandus* by Westergård (1946, pl. 4, figs. 21, 22). These specimens are refigured herein on Plate 11. An inspection of rubber casts of these specimens reveals the following differences: (1) in the holotype cephalon (Pl. 11, fig. 1 herein) the glabella expands slightly forwards whereas in the Närke specimen (Pl. 11, fig. 3 herein), the glabella contracts forwards; (2) the pygidial axis of the Scania specimen (Pl. 11, fig. 2 herein)

is more sharply pointed and does not extend as far to the posterior when compared with the Närke specimen (Pl. 11, fig. 4 herein); and (3) the clavagnostid pits of the Scania pygidium are shallow and longitudinally elongated whereas those of the Närke pygidium are deep and only slightly elongated. The figure of the holotype cephalon given by Westergård (1946, pl. 4, fig. 19) shows a prominent elongated glabellar node. However, although our photograph (Pl. 11, fig. 1) of a rubber cast of the holotype shows a faint trace of what may be an elongated node, the node is not as prominent as suggested by Westergård's figure. It should be pointed out here that most of Westergård's figures have been retouched.

The differences noted above indicate that the specimens from the two different Swedish localities should be placed in different species, with the specimens from Scania being retained as the type material of *Clavagnostus repandus* and the material from Närke being the basis of a new species. Also, in view of the lack of detailed knowledge of the stratigraphy of *Paradoxides forchhammeri* beds in Närke (see Westergård, 1946, p. 17) it is questionable whether the two species are of the same age.

The Siberian specimens illustrated in Chernysheva (1960, pl. 1, figs. 12, 13) as *C. repandus* are very similar to the type material of *C. repandus* from Scania. The most significant difference appears to be that the pygidial border spines of the Siberian form are placed much further to the posterior than in the form from Scania. In addition the cephalic node appears to be stronger and the clavagnostid pits deeper in the Siberian material than in the type *repandus*.

Holm and Westergård (1930, pl. 1, figs. 35–39) figured three cephala and two pygidia as *C. repandus* from a late Middle Cambrian sequence on Bennett Island, north of Siberia. These specimens appear to belong to a species different from the holotype cephalon and the pygidium figured by Westergård (1946) from Scania. Although the pygidia of the two forms are close, the cephala are clearly different. The glabella of the holotype expands forward and is subsquare whereas that of the Bennett Island specimens also differs from the Närke form of '*C. repandus*'. The cephalon from Närke figured by Westergård, 1946, pl. 4, fig. 21 (refigured herein, Pl. 11, fig. 3), has a more angular glabellar rear than do the cephala from Bennett Island. The pygidia also differ; the pygidial axis of the Bennett Island form does not extend as far to the posterior as does the pygidial axis of the pygidium from Närke (Pl. 11, fig. 4 herein).

Holm and Westergård (1930, pl. 1, figs. 40–43) also figured four cephala questionably assigned to *C. repandus*. These cephala are poorly preserved, and it is difficult to make a meaningful comparison with other material. However, as noted in Holm and Westergård (1930, p. 14), two of these cephala (figs. 42, 43) have quite narrow glabellas. The cephalon figured in Holm and Westergård (1930, pl. 1, fig. 40) has what appears to be a preglabellar median furrow although this is probably caused by crushing.

The above discussion indicates that four (and probably five) different species of *Clavagnostus* have been described as *C. repandus*. They are the specimens from

(1) Andrarum Limestone, Andrarum, Scania, Sweden; holotype cephalon and pygidium figured in Holm and Westergård (1930, pl. 4, figs. 11, 12), in Westergård (1946, pl. 4, figs. 19, 20), and herein as Pl. 11, figs. 1, 2.

(2) Sköllersta, Närke, Sweden; cephalon and pygidium figured in Westergård (1946, pl. 4, figs. 21, 22), and herein as Pl. 11, figs. 3, 4.

(3) River Judoma, east Siberia, as figured in Chernysheva (1960, pl. 1, figs. 12, 13).
(4) Bennett Island, north of Siberia, as figured in Holm and Westergård (1930, pl. 1, figs. 35–39).
(5) Bennett Island, north of Siberia, as figured in Holm and Westergård (1930, pl. 1, figs. 40–43).

As noted above, the concept of *C. repandus* (Westergård) should be confined to the cephalon and the pygidium from Scania. The other material needs to be redescribed.

The two pygidia from north-west Siberia figured as *C. sulcatus* Westergård in Lazarenko and Nikiforov (1968, pl. 3, figs. 13, 14) are similar to the pygidium of *C. sulcatus* as figured in Westergård (1946, pl. 4, fig. 26) and herein as Pl. 11, figs. 6, 8. Until cephala are found with the Siberian specimens, it cannot be certain that the two pygidia figured by Lazarenko and Nikiforov do belong in *C. sulcatus*. Photographs taken with low angled light (see Pl. 11, fig. 8) reveal that the pygidium of *C. sulcatus* figured by Westergård (1946, pl. 4, fig. 26) has very shallow depressions along the outer lateral parts of the acrolobe. There appear to be four pairs of these depressions with the two central ones being the most prominent.

The pygidium of *Clavagnostus chipiquensis* (Rusconi) is illustrated by Poulsen (1960, pl. 1, fig. 14) and herein Pl. 11, fig. 11. The cephalon of *chipiquensis* is not described by Poulsen. However, the pygidium figured by Poulsen (1960, pl. 1, fig. 13) as the holotype of *Peronopsis ultima* Poulsen appears to be a *Clavagnostus* cephalon. An inspection of a rubber cast of this specimen reveals the presence of a basal lobe (the other one is not preserved) and traces of long cephalic spines (see Pl. 11, fig. 10). The glabellar front is pointed, and there is a preglabellar median furrow. This cephalon is similar to that of *C. burnsi* sp. nov. and is probably the cephalon of *C. chipiquensis* (Rusconi).

Öpik (1967, p. 113) recognized two separate genera in the different species described as *Clavagnostus*, with *C. repandus* (Westergård 1930) and *C. sulcatus* Westergård, 1946 representing the different genera. The writers agree with Öpik in differentiating these species into separate groups. However, there seems to be a third group of species which can be placed in *Clavagnostus* as presently conceived and which is intermediate between the forms represented by *C. sulcatus* and *C. repandus*. This third group is represented by *C. burnsi* sp. nov. from Riana, Tasmania. It is characterized by a pygidium similar to that of *C. repandus* and a cephalon similar to that of the *C. sulcatus* group in that it has a preglabellar median furrow and an angular glabellar front although it is distinct from *sulcatus* in that the cephalic anterior is not pointed.

The described species of *Clavagnostus* can be placed in three groups.

1. The *C. repandus* group which is characterized by a rounded glabellar front, no preglabellar median furrow, and a blunt pygidial axis which reaches the posterior border (see Pl. 11, figs. 1–4, 12–17). The known members of this group include all the species which have previously been placed in *C. repandus* (Westergård), plus *C. milli* sp. nov.

2. The *C. burnsi* group which is characterized by an angular glabellar front, a preglabellar median furrow, and a blunt pygidial axis which reaches the posterior border.

C. burnsi sp. nov. and probably *C. chipiquensis* (Rusconi) are members of this group. C.(?) *rawlingi* sp. nov. is related to this group.

3. The *C. sulcatus* group of species is characterized by a preglabellar median furrow and a pointed pygidial axis which does not usually reach the pygidial border. The group includes *C. sulcatus* Westergård, 1946, *C. bisectus* Öpik, 1967, *C. repandiformis* Kobayashi, 1943, *C. ovalis* Pokrovskaya, 1960*b*, *C. aequalis* Howell, 1937, and probably *Tomorhachis spinosa* Resser, 1938. The last two species are known only from their pygidia. The species with known cephala have angular glabellar fronts with the exception of *ovalis* which has a rounded or subangular glabellar front. *C. sulcatus* differs from other members of the group by having a pointed cephalic front (see Pl. 11, figs. 5, 7, 9). *C. repandiformis* has very long cephalic and pygidial spines. No photograph of *C. ovalis* is available, but the diagram given by Pokrovskaya (1960*b*, p. 161, fig. 44) shows that the pygidial axis extends to the border. In other species in the *C. sulcatus* group the pygidial axis stops short of the border.

The different combination of characters noted above in groups 1, 2, and 3 and the variation within the groups emphasizes the close and gradational relationship of all the species discussed above. The discovery of *C. burnsi*, intermediate between the *C. repandus* and *C. sulcatus* groups, raises the question of whether or not these groups belong in separate genera as suggested by Öpik (1967, p. 113). As noted by Öpik (1967, p. 114), if the as-yet-unknown cephalon of *Tomorhachis spinosa* is found to be similar to those of the *C. sulcatus* group, then the species of this group could be placed in the genus *Tomorhachis*. It would also be possible to erect a new genus to accommodate members of the *C. burnsi* group and have a total of three genera for the species discussed above. However, in view of the close and gradational relationship between the three groups, additional generic names seem unwarranted. The authors consider that all the species noted above should be included in the single genus *Clavagnostus*. Öpik (1967, p. 114) raised the possibility of *Clavagnostus* being a subjective synonym of *Aspidagnostus*, but the differences between *Clavagnostus* and *Aspidagnostus* seem great enough to warrant generic separation.

EXPLANATION OF PLATE 11

Figs. 1, 2. Rubber casts of cephalon and pygidium of *Clavagnostus repandus* (Westergård) from Andrarum Limestone, Andrarum, Scania. 1, holotype cephalon, ×11·2; 2, pygidium, ×11·3.

Figs. 3, 4. Rubber casts of cephalon and pygidium figured by Westergård 1946, pl. 4, figs. 21, 22 as *Clavagnostus repandus* (Westergård) from Sköllersta, Närke. 3, cephalon, ×13·5; 4, pygidium, ×14·5.

Figs. 5–9. Rubber casts of *Clavagnostus sulcatus* Westergård from Gudhem, Västergötland. 5, holotype cephalon figured by Westergård 1946, pl. 4, fig. 25; ×12·3. 6, pygidium figured by Westergård 1946, pl. 4, fig. 26; ×11·2. Fig. 8 is the same specimen as fig. 6 photographed in low angle light in an attempt to accentuate the very shallow depressions near the acrolobe margins. 7, cephalon, figured by Westergård 1946, pl. 4, fig. 24; ×10. 9, cephalon figured by Westergård 1946, pl. 4, fig. 23; ×11·8.

Figs. 10, 11. Rubber casts of *Clavagnostus chipiquensis* (Rusconi) from Argentina. 10, cephalon figured by Poulsen 1960, pl. 1, fig. 13 is the holotype pygidium of *Peronopsis ultima* Poulsen; ×10. Note the presence of the left basal lobe and the traces of the right cephalic spine. 11, pygidium figured by Poulsen 1960, pl. 1, fig. 14; ×10.

Figs. 12–17. *Clavagnostus milli* sp. nov. Lower fauna at Christmas Hills. 12, UT 86860b, holotype cephalon, ×15·3. 13, UT 86853b, cephalon, ×13·1. 14, UT 86869e, cephalon, ×13·8. 15, UT 86607, pygidium, ×10·9. 16, UT 92479, pygidium, ×10·8. 17, UT 92469, pygidium, ×10.


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JACO and DAILY, *Clavagnostus*

The cephalon described by Schmidt (1942, p. 351, pl. 21, figs. 10*a*, *b*, *c*) from Doberlug, Germany, as *Hypagnostus* cf. *parvifrons* (Linnarsson) and assigned to *Clavagnostus*? sp. by Sdzuy (1957, p. 10) has a wider glabella than any known species of *Clavagnostus*. This cephalon should be removed from *Clavagnostus*.

Clavagnostus milli sp. nov.

Plate 11, figs. 12–17

Material. Three cephala and three pygidia are used for descriptive purposes. A few other specimens of this rare species are known.

Holotype. The best preserved cephalon, UT 86860b (Pl. 11, fig. 12), is selected as the holotype.

Diagnosis. Cephalon with well-rounded glabellar front, anteriorly placed glabellar node, angular glabellar rear, and very long, markedly divergent cephalic spines; no preglabellar median furrow. Pygidium with wide axis extending posteriorly on to border; simplimarginate, with long border spines.

Description. Markedly convex cephalon about as wide as long. Moderately wide, convex, elevated rim; narrow, shallow marginal furrow. No preglabellar median furrow. Very long, markedly divergent spines arise from broad tumid bases. Glabella length 0·65 to 0·7 that of cephalon; at its widest glabella width between 0·25 and 0·3 that of cephalon. Strongly convex glabella has an elliptical outline; it is bounded by narrow, moderately deep axial furrows which shallow to the anterior. Cheeks smooth. Large basal lobes with narrow connecting band behind angular glabellar rear. Small node on anterior part of glabella. In front of this node the glabella is somewhat depressed; this depressed area probably represents an anterior glabellar segment. Glabella is widest in region of node.

Moderately convex pygidium about as wide as is long. Moderately wide lateral borders; moderately wide, convex, elevated rim; shallow marginal furrow. Long divergent border spines. Wide posterior border with a narrow posterior marginal furrow and a wide, flatly convex, elevated rim. Narrow, shallow shoulder furrows; narrow shoulders with fulcra placed about midway between acrolobe margins and axial furrows. Narrow (sag.) convex articulating half-ring; narrow articulating furrow is shallow at centre and deepens abaxially. Smooth pleural areas.

Pygidial axis extends full length of acrolobe and protrudes slightly on to the border; axis outlined by moderately wide and deep axial furrows. Large clavagnostid pits occur about two-thirds of distance from anterior to posterior of axis. Strongly convex anterior part of axis is distinctly elevated above the pleural fields. Posterior part of axis is very slightly depressed beneath level of adjacent pleural regions.

Axis wide at anterior (about 0·4 width of pygidium); it is very slightly constricted in the region of a second axial segment. From a little distance anterior of the pits, the axial furrows are straight and converge evenly to the posterior marginal furrow. Width of axial posterior about 0·2 to 0·25 that of distance between spines. Prominent, centrally placed, elongated node or keel on anterior part of axis. No sign of transverse axial furrows on anterior part of axis.

Discussion. Clavagnostus milli is closest to *C. repandus* of the described species of *Clavagnostus*. The long cephalic and pygidial spines distinguish *milli* from *repandus*.

The pygidium of *C. chipiquensis* (Rusconi), illustrated by Poulsen 1960 (pl. 1, fig. 14) and herein (Pl. 11, fig. 11), is similar to that of *milli*. The axis of *milli* seems to be wider in relation to the width of the acrolobe than that of *chipiquensis*. As noted above, the cephalon of *C. chipiquensis* may be the specimen described by Poulsen as *Peronopsis ultima*. If this is so, then *C. chipiquensis* is in the *C. burnsi* group of species whereas *C. milli* is in the *C. repandus* group of species.

Occurrence and age. Lower fauna at Christmas Hills (lat. 40° 54·1′ S., long. 144° 29·8′ E.); its age is late Middle Cambrian, probably of the *Lejopyge laevigata* I Zone (Jago and Buckley 1971).

Clavagnostus burnsi sp. nov.

Plate 12, figs. 1–10

Material. Most of the Riana material comes from an approximately 5 mm thickness of sediment. The five cephala and five pygidia illustrated show the essential features of this species.

Holotype. The cephalon, UT 92584, figured as Pl. 12, fig. 8, is selected as holotype.

Diagnosis. Cephalon strongly convex with narrow, shallow marginal furrow and moderately wide, elevated rim and long thin cephalic spines; glabellar front pointed, rear angular; preglabellar median furrow shallows anteriorly and does not always reach marginal furrow. Pygidium moderately convex with narrow shallow marginal furrow and moderately wide convex elevated rim; posterior rim wider than lateral, with long thin border spines; pygidial axis lanceolate extending to posterior border; median elongated ridge along anterior part of axis; shallow clavagnostid pits in posterior part of axis which is depressed below level of smooth pleural areas; posterior end of axis bluntly rounded, narrow axial rear.

Description. Small strongly convex cephalon has steep acrolobe margins. Border consists of narrow, shallow marginal furrow and a moderately wide elevated rim. Border narrows slightly to posterior. Long, thin spines emerge from low on postero-lateral corners.

Glabella outlined by narrow, moderately deep furrows. Smooth cheeks divided in front by a preglabellar median furrow which is moderately deep at the posterior but shallows anteriorly and does not always meet the marginal furrow. In some figured specimens the convexity of the cephalic acrolobe obscures the fading of the pre-glabellar furrow. In some specimens it tends to widen slightly at the anterior. Glabella has a length about 0·65 that of cephalon. Glabellar rear, angular. Small, simple, unconnected basal lobes. Narrow glabella is widest just in front of basal lobes where it is about 0·4 to 0·45 the width of cephalon. From its widest the glabella narrows gradually to a sharply pointed front; glabella has an over-all elongated tear-drop outline. Glabella smooth except for anterocentrally placed, low, elongated node (not visible in figured specimens).

Moderately convex pygidium about as wide as is long. Moderately wide border consists of a narrow, shallow marginal furrow and a moderately wide, convex, elevated rim. Posterior rim is a little wider than lateral rims which narrow anteriorly; border spines, long and thin. Shoulder furrows continuous with marginal furrows; shoulders, convex, elevated; fulcra placed just abaxial to midpoint between axial furrows and anterolateral corners. Articulating device is nowhere well preserved.

Pleural areas smooth. Axis extends entire length of acrolobe; it is outlined by narrow, moderately deep axial furrows. No sign of transverse axial furrows. Clavagnostid pits occur posteriorly about 0·65 to 0·70 the distance from the anterior to the posterior of axis. Posterior part of axis is depressed below level of pleural areas; anterior part of axis stands out somewhat above pleural areas. Elongated ridge extends along centre of anterior part of axis.

Discussion. The position of *Clavagnostus burnsi* in relation to other species of *Clavagnostus* is discussed above. If the specimen figured by Poulsen (1960, pl. 1, fig. 13) as the pygidium of *Peronopsis ultima* is the cephalon of *C. chipiquensis* (Rusconi), then this is the nearest species to *C. burnsi*. The cephala are very similar. However, the pygidial spines of *C. burnsi* are larger than those of *chipiquensis*. The bluntly rounded pygidial axial rear of *chipiquensis* is wider than the rather narrow axial rear of *burnsi*. The clavagnostid pits of *C. burnsi* are placed slightly more to the posterior than those of *C. chipiquensis*. The differences between *C. burnsi* and *C.*(?) *rawlingi* sp. nov. are noted in the discussion of *rawlingi*.

Occurrence and age. C. burnsi comes from within the upper sedimentary sequence of Radfords Creek Group of the Dial Range Trough (Burns 1964) as exposed near Riana in a quarry at lat. 41° 13·0′ S., long. 146° 00·2′ E. and also at lat. 41° 12·7′ S., long. 146° 00·00′ E.; its age is early Upper Cambrian, Mindyallan Stage (Jago 1972*a*).

Clavagnostus(?) *rawlingi* sp. nov.

Plate 12, figs. 11, 12

Material. One cephalon, UT 92719, and one pygidium, UT 92727, from the same locality near St. Valentines Peak are provisionally placed in the same species. The pygidium has slightly pitted pleural areas, a feature not previously seen in any species of *Clavagnostus*; however, the other characters of the pygidium indicate that it belongs to *Clavagnostus* or a closely related genus.

Holotype. The pygidium, UT 92727 (Pl. 12, fig. 12), is selected as holotype.

Diagnosis. Cephalon with long narrow glabella with pointed front and rounded or subrounded rear; preglabellar median furrow well developed. Pygidium with wide posterior margin; axis slightly shorter than pleural areas; wide elongated median ridge on anterior part of axis; clavagnostid pits elongated with posterior ends connected with axial furrows; pleural areas gently pitted near marginal furrow in posterior two-thirds of pygidium.

EXPLANATION OF PLATE 12

Figs. 1–10. *Clavagnostus burnsi* sp. nov. Quarry near Riana. 1, UT 92600, cephalon, ×14. 2, UT 92600, cephalon, ×13·2. 3, UT 92585, pygidium, ×20·8. 4, UT 92585, pygidium, ×17·5. 5, UT 92584, cephalon, ×30. 6, UT 92594, pygidium, ×17. 7, UT 92593, cephalon showing fading of preglabellar median furrow, ×18·5. 8, UT 92584, holotype cephalon, ×23. 9, UT 92584, pygidium, ×20. 10, UT 92597, pygidium, ×15·8.

Figs. 11–12. *Clavagnostus*(?) *rawlingi* sp. nov. Near St. Valentines Peak. 11, UT 92719, cephalon, ×18·7. 12, UT 92727, holotype pygidium, ×17.

Fig. 13. *Clavagnostus* sp. 2. Timber track on west side of Sugarloaf Gorge. 13, UT 92601, pygidium, ×21·4.

Fig. 14. *Clavagnostus* sp. 1. Upper fauna at Christmas Hills. 14, UT 86872i, pygidium, ×22.

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JAGO and DAILY, *Clavagnostus*

Description. Cephalon about as wide as is long. Narrow, moderately deep marginal furrow and a convex, elevated, moderately wide rim. Posterior furrows are wide and deep at the margins becoming shallower adaxially, and if they reach the glabellar furrows, they do so faintly. Posterior rims are wide, elevated, and convex; they narrow adaxially. Posterolateral spines are not visible; the one spine base present is large. The basal lobes, which are connected behind the rounded (or subrounded) glabellar rear, are not clearly outlined and appear to merge both with the cheeks and the posterior rim. There are pits and depressions on the cheeks of the single available cephalon, but it cannot be determined whether or not these are natural or due to tectonism. Glabella, long (about 0·7 length of cephalon) and narrow (about 0·2 width of cephalon at widest part of glabella). Glabella is outlined by moderately deep axial furrows. Moderately deep preglabellar median furrow extends to marginal furrow. Glabella has an elongated spearhead outline with a pointed front. Large, centrally placed, elongated node reaches its maximum elevation at its anterior.

Pygidium has a wide posterior border between short, thick, elevated border spines. Narrow, shallow, marginal furrow; rim is wide and gently convex between the spines, with a short median region which extends forward to meet the axis. Lateral rims narrow anteriorly. Shoulder and marginal furrows are continuous; narrow, convex shoulders; neither the facets nor the fulcra are clearly visible. Narrow, shallow articulating furrow arches gently to the posterior. Narrow, articulating half-ring has an elongated lens-shaped outline. Pleural areas gently pitted close to the marginal furrow in central and posterior parts of the pygidium. Axis does not extend as far to the posterior as do the pleural areas; it has a wide, blunt posterior margin. No transverse furrows are visible on the anterior part of the axis. Deep, narrow axial furrows; from the anterior they converge gradually to a position (0·25 length along axis) where the axis is about 0·25 the width of the pygidium. From this constriction the furrows diverge until axis is widest at about its midpoint, where it is about 0·3 the width of the pygidium. From the midpoint the axial furrows are straight and converge to the axial posterior where the axis has a width about 0·1 that of pygidium. Strongly elevated median ridge (about one-third axial width) is most prominent between anterior waist and midpoint of axis and also extends forward less prominently to articulating furrow. Ridge is widest at axial constriction. Two deep, longitudinally elongated, clavagnostid pits occur in the posterior part of the axis. From their anteriors the pits are arched adaxially to join the axial furrows about 0·8 of the distance from the anterior to the posterior of the axis. Across the anterior end of the pits is a moderately deep, transverse furrow.

Discussion. The combination of a very narrow glabella, elongated clavagnostid pits which meet the axial furrows, and pitted pleural areas probably indicates that *rawlingi* does not belong in *Clavagnostus* but in a closely related new agnostid genus. Although there are no other specimens with which either the one available cephalon or the one known pygidium can be linked, it is not absolutely certain that the cephalon and the pygidium described above belong in the one species. Hence *rawlingi* is placed questionably in *Clavagnostus*.

As noted in the generic discussion, *Clavagnostus*(?) *rawlingi* appears to be related to the *C. burnsi* group of species. *C.*(?) *rawlingi* differs from all known species of *Clavagnostus* in that the pygidial pleural areas are slightly pitted. The unique nature

of the clavagnostid pits also distinguishes *C.* (?) *rawlingi* from all species of *Clavagnostus*. The width of the glabella in relation to that of the cephalon is less in *rawlingi* than in any species of *Clavagnostus*. The pygidial spines and pygidial axis of *rawlingi* are shorter than those of either *C. chipiquensis* (Rusconi) or *C. burnsi* sp. nov.

Occurrence and age. Clavagnostus(?) *rawlingi* sp. nov. comes from near St. Valentines Peak, lat. 41° 21·6′ S., long. 145° 44·3′ E.; its age is either late Middle Cambrian *Lejopyge laevigata* III Zone or the Middle Cambrian/Upper Cambrian Passage Zone (Jago 1972*b*).

Clavagnostus sp. 1

Plate 12, fig. 14

Material. One reasonably well-preserved, partial pygidium (UT 86872i) is available.

Description. Moderately convex pygidium; moderately wide gently convex rim and a narrow, shallow marginal furrow. Long, well-developed border spines. Shoulder areas, not visible. Narrow (sag.), convex articulating half-ring extends almost full width of axis; narrow, shallow articulating furrow. Anterior part of axis (in front of clavagnostid pits) stands out well above the smooth pleural areas. At the pygidial anterior the axis has a width about 0·3 that of the pygidium. Axis is outlined by narrow, shallow furrows; it does not extend as far to the posterior as do the pleural fields. Clavagnostid pits, poorly outlined; they occur toward the posterior of the axis about 0·75 of the distance along the axis. On the anterior part of the axis is a long, centrally placed ridge.

Discussion. As only one specimen is known, this pygidium is referred to *Clavagnostus* sp. 1. It differs from *C. milli* in that (*a*) the axis of *Clavagnostus* sp. 1 does not extend to the posterior border, whereas that of *C. milli* extends slightly on to the border and (*b*) the pits of *Clavagnostus* sp. 1 are placed more to the posterior than those of *C. milli*.

Occurrence and age. Clavagnostus sp. 1 comes from the upper fauna at Christmas Hills (lat. 40° 54·1′ S., long. 144° 29·8′ E.); its age is late Middle Cambrian, either of the *Lejopyge laevigata* I Zone or the *L. laevigata* II Zone.

Clavagnostus sp. 2

Plate 12, fig. 13

Material and measurement. One poorly preserved pygidium, UT 92601, of length (including articulating half-ring), 1·4 mm is available.

Description. Moderately convex pygidium about as wide as is long. Narrow, shallow marginal furrow; wide, flatly convex rim. Posterior margin extends slightly forward at its centre to meet axis. Border spines of indeterminate length are present. Articulating furrow seems narrow and shallow with a shallow pit at either end; articulating half-ring appears narrow (sag.) and gently convex. Pleural areas probably smooth. Axis outlined by wide, deep furrows. Clavagnostid pits found about 0·65 of distance from anterior to posterior of axis. Anterior part of axis stands out well above pleural areas; pleural areas sit well above axial posterior.

Discussion. This specimen is too poorly preserved to assign it to any particular species, and it is referred to *Clavagnostus* sp. 2.

Occurrence and age. Clavagnostus sp. 2 comes from a siltstone exposed along an old timber track on the west side of Sugarloaf Gorge, lat. 41° 15·4′ S., long. 146° 04·2′ E. It comes from within the lower sedimentary sequence of the Radfords Creek Group of the Dial Range Trough (Burns 1964); its age is probably of the late Middle Cambrian, *Lejopyge laevigata* III Zone or the Middle Cambrian/Upper Cambrian Passage Zone (Jago 1972*a*).

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J. B. JAGO
Department of Applied Geology
South Australian Institute of Technology
North Terrace
Adelaide, South Australia 5000

B. DAILY
Department of Geology and Mineralogy
University of Adelaide
G.P.O. Box 498B
Adelaide, South Australia 5001

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